The Lake-Level of the Victoria Nyanza
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Sir William suggests the dredging and embankment of the Bahr el Zaraf throughout, and its use as an additional channel for the summer supply. Sir William admits that this scheme would not be as satisfactory as the embanking of the Bahr el Gebel throughout the length of the marshes, but it would involve an expenditure of only £1,250,000.

A third scheme is, however, put forward, and this Sir William evidently thinks preferable to either of the others. He proposes to convert Lake Tsana into a reservoir, and thus store sufficient water for the needs both of Egypt and the Sudan, and at the same time improve the navigation of the Blue Nile during the summer months. He supposes Lake Tsana to have an area of 3300 square kilometers (according to Dr. Stecker's survey, the area is only 2980 square kilometers). A rise of the lake of 5 meters would thus yield 16,500 million cubic meters. Allowing 3300 million cubic meters to be lost by evaporation, there would remain 4000 million for Egypt, whilst the balance could be made use of in the Sudan. No objection could be raised against this scheme, notwithstanding the fact that Sir William seems to be but imperfectly acquainted with the geographical features of the region with which he deals, if Lake Tsana were in the possession either of Egypt or of England. But who dare answer for the political future of Abyssinia? The Emperor Menelek might grant permission for the desired works to be carried out, but who can say what might be done by his successors? The destruction of a dam at the outlet of Lake Tsana might involve Dar Sennar in a great disaster. It certainly seems to us that something ought to be done for the irrigation of the rich alluvial soil extending for 700 kilometres along the Blue Nile from Rosaires to Khartum, but might not this object be attained more readily by building a dam across the Blue Nile above Rosaires, within Egyptian territory, and by damming up some of the "khors" which find their way into that river from the Abyssinian highlands?

THE LAKE-LEVEL OF THE VICTORIA NYANZA.

By E. G. RAVENSTEIN.

THE record of the lake-level of the Victoria Nyanza was begun in January, 1896, by direction of Sir Ernest J. L. Berkeley, Her Majesty's Commissioner. The execution of this inquiry was intrusted by him to Mr. R. J. D. Macallister. Gauges were erected at Ntebe (Port Alice), the lake port of the capital; at Lubwa's (now Fort Thruston), near the outlet of the Nile; and at Port Victoria, in Berkeley bay. Care was taken to secure solid foundations for these gauges, so as to prevent a subsequent settlement. It was deemed sufficient to observe the lake-level once daily. An arbitrary datum level had, as a matter of course,

to be adopted for each station, but all observations published in the Reports of the British Association have been reduced to the mean lake-level at each station for the year 1896 by deducting 15·5 inches from the recorded readings at Ntebe, 18·46 inches in the case of Fort Thruston, and 36·53 inches in that of Port Victoria. On October 1, 1898, Mr. C. W. Fowler, Superintendent of Marine, adjusted all observations to the readings taken at Port Victoria, and since that date 36·53 inches have been deducted for each of the three stations.

Owing to political troubles, no record was kept at either station during thirteen months, from the beginning of August, 1897, to the end of the same month, 1898; whilst from Fort Thruston there are no reports for an additional two months, namely, for November and December, 1899. At Port Victoria the observations were discontinued

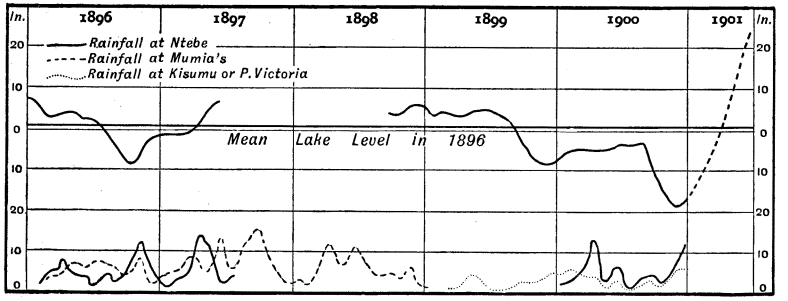

DIAGRAM ILLUSTRATING THE FLUCTUATIONS IN THE LEVEL OF THE VICTORIA NYANZA, AT NTEBE, IN 1896–1901 (UPPER CURVE), COMPARED WITH THE RAINFALL (LOWER CURVES).

at the end of July, 1899, but a new gauge was set up in September, 1899, at Kisumu, the Government post near Port Florence on Ugowe or Kavirondo bay. The records there were reduced to the extent of 30·3 inches to obtain an approximation of the lake-level as recorded.

The records for Ntebe, up to the close of the year 1900, embrace thus three full years and eleven months, those for Fort Thruston 45 months, for Port Victoria 30 months, and Kisumu 16 months.

The general results, as far as Ntebe is concerned, may be thus summarized:

	1896.	1899.	1900.
Mean lake-level ...	0·0	−0·51 in.	− 8·13 in.
Highest level ...	Jan. 1 + 8·5 in.	June 8 + 6·47 in.	July 21 − 2·03 in.
Lowest level ...	Oct. 10 − 10·0 in.	Nov. 28 − 10·03 in.	Nov. 21 − 19·53 in.
Range	18·5 in.	16·50 in.	17·50 in.

The lake-level, to judge from the incomplete returns available, fell in the course of 1897, rose again slightly in 1898, only to fall again in

1899, and still more in 1900, when it reached its lowest level apparently for many years past. In 1901, however, an almost startling recovery took place, and by June 1 of the present year its level had risen 24 inches above the mean level of 1896.* The extreme range since the beginning of 1896 has thus been 43·53 inches, but if there is any truth in what the Roman Catholic missionaries in Buganda told Mr. Macallister (see 'Egypt,' No. 2 (1901), p. 49), that the mean level of the lake twenty years ago (*i.e.* in 1881) exceeded that of the year 1898 to the extent of 8 feet, the extreme range, as far as our experience goes, may be assumed to amount to at least 10 feet. Under these circumstances, a permanent raising of the lake-level to that extent, by constructing a

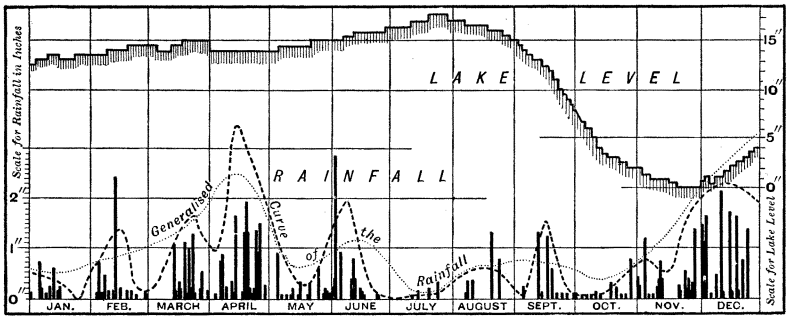

DIAGRAM ILLUSTRATING THE FLUCTUATIONS IN THE LEVEL OF THE VICTORIA NYANZA, AT NTEBE, IN 1900, COMPARED WITH THE RAINFALL.

regulating dam at Fort Thruston, is not likely to be attended by the disastrous consequences which seem to be dreaded by Sir W. Garstin.

The normal rise and fall of the lake-level is primarily governed by the rainfall throughout its catchment basin, and to a minor extent by differences in the amount of evaporation. A permanent fall of its level might even result from a natural deepening of the channel of the Nile where it leaves the lake. Of such a deepening, however, there is at present no evidence.

As to the rainfall, our information is still of a very fragmentary nature. We know, however, that the amount of rain varies not only with the succeeding seasons, but also locally. At Mengo, the capital of Buganda, 55 inches of rain fell in 1881, and only 35 inches in 1893. In the year 1894–5 90 inches were registered at the Bukoba station on the western shore of the lake, as compared with 49 inches on the southern extremity of the lake at Muanza. In 1897–8 73 inches fell at Bukoba, and 92 inches at Mumia's, in Kavirondo, towards the

* Sir William Garstin accounts for this sudden rise by supposing the sadd in the Kagira river to have been set free, thus producing a flood.

north-east. In the hills to the east of Mumia's the rain is known to be still heavier. In 1896–7 63 inches fell at Ntebe, 73 inches at Mumia's; in 1900 61 inches at Ntebe, and 49 at Kisumu. Many facts tend to prove that it is not local rains which appreciably affect what may be called the mean daily level of the lake, but precipitation throughout its vast drainage area.

A rainfall of 2·36 inches on November 14, 1896, only caused a rise of the lake to the extent of 0·75 inch, whilst the heavy rains during October and November (16·64 inches) only affected the lake to the extent of 5 inches. At Ntebe, between March 20–24, 1900, 3·7 inches of rain fell, and in the course of April 1 13·54 inches, yet the level of the lake remained unaffected, the heavy local rains being balanced by the outflow and loss by evaporation, or neutralized owing to a deficiency of rainfall elsewhere. On the other hand, in the course of May the lake rose slowly, but steadily, although very little rain was registered locally.* More remarkable still, on September 12 1·25 inches of rain fell, yet the lake-level actually fell half an inch.

Among the causes which exercise an incidental influence upon the lake-level the winds are probably the most powerful. There are regular land and lake breezes, and Mr. Macallister remarks that a strong south-west breeze will cause a rise in the level of the lake to an extent of from 1 to 3 inches; and at Fort Thruston, on November 13, a severe storm actually caused the lake to rise 3 inches. In order to ascertain the effect of the winds, it would be necessary to make at least three observations daily, or to set up a self-registering gauge.

Further fluctuations of the lake-level are undoubtedly due to differences of barometric pressure over parts of its surface, and there may be *seiches*, and perhaps even tidal movements. A successful study of these phenomena would necessitate the establishment of at least four gauges on the lake-shore (in the north, south, east, and west). These stations should be provided with self-registering apparatus, their altitudes should be determined by careful levelling, and the observations should, as a matter of course, embrace all the usual atmospheric phenomena.

The diagrams accompanying this notice explain themselves. For further information the reader is referred to the Reports of a committee of the British Association on the Climatology of Africa, of which the writer of this notice is chairman.

* At Fort Thruston between May 12 and 13 the lake rose four inches, although no rain fell.